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ABSTRACT

This study was designed to determine: (1) the level of understanding of selected science concepts typical of freshmen and senior University of Wyoming elementary education students; (2) relationships between the number and kind of science courses taken by elementary education majors and their level of understanding of science concepts; and (3) if there is a significant difference in attitudes toward science of freshmen (N=29) to seniors (N=43). Other objectives were to determine: any correlations between number and types of science courses completed and (a) students' attitudes toward teaching science and (b) their confidence in their ability to teach science; any sex differences in understanding, attitude, and confidence; and any correlation between attainment test scores and attitudes and confidences. Results obtained appear to substantiate the following interpretations. University of Wyoming elementary education students are being inadequately prepared to teach science in terms of attainment of a reasonable level of understanding of scientific concept currently included in elementary school science curricula. It appears that simply having these students take greater doses of traditional college science courses does not favorably impact understanding of science concepts, attitudes toward science, or confidence in personal ability to teach science. Freshmen appear to have a significantly serious negative attitudinal complex regarding science and science teaching. Though there is a discernible trend in the direction of positive attitudes toward science by students as they mature from freshmen to senior level, this trend is completely unrelated to the number of standard general education science courses completed. (JN)

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A Study of Scientific Conceptions and Attitudes Toward Science of Prospective Elementary Teachers

A Research Report

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and

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Presented at
Northern Rocky Mountain
Educational Research Association

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Overview

Teachers are the key to quality of children's learning in the classrooms of our nation. Unfortunately, a recent avalanche of reports from national commissions and foundations document a dismal situation in elementary science education: Many (perhaps most) of the teachers in our elementary schools are not qualified to teach science. National Science Board (1983), Task Force on Education (1983), and Feistritzer (1983) report that the "typical" elementary teacher dislikes science, fears it, and does not understand it.

Since universities hold virtually all of the responsibilities for preparing future elementary teachers to teach science, it would seem critical at this time to assess levels of understanding of science, attitudes toward science and confidence in teaching science, of elementary teachers-in-training. Does the existing four-year program at Universities advance the accuracy of scientific understandings of prospective elementary teachers? Does it improve their attitudes toward science and toward teaching of science? This study is intended to collect data regarding these and some closely related questions.

Objectives

This study was designed to determine:

1) The level of understanding of selected science concepts typical of freshman and senior U.W. elementary education students.
2) Relationships between the number and kind of science courses taken by elementary education majors and their level of understanding of science concepts.
3) If there is a significant difference in attitudes toward science of freshmen compared to seniors.

4) If there is a correlation between the number and types of science courses completed and attitudes toward science and teaching of science.
5) If there is a correlation between number and types of science courses taken by prospective elementary teachers and their confidence in their own abilities to teach science to elementary children.
6) If there is a difference between male and female students in understanding of science concepts, attitudes toward science, and confidence in teaching science.
7) If there is a correlation between scores on the content attainment test and attitude toward science.
8) If there is a correlation between scores on the content attainment test and confidence in teaching science.

Review of Relevant Literature

Cohen (1982), Flegg (1981) Naussbaum and Novick (1981) have collected considerable evidence that a large number of adults, including prospective elementary teachers, give responses similar to those of elementary school children when interviewed on fundamental science concepts such as phases of the moon, formation of mountains, lakes and rivers, and sinking or floating of objects in liquids. One reason for this lack of understanding, according to Flegg, is that even though many people are interested in science, it is frequently presented in a form so complex in school programs it seems to be above the level of understanding of the average person. As a result, many people become alienated from science and are unable to learn scientific concepts.

In spite of the drastic need for science instruction and serious concerns raised recently in the mass media by science educators and politicians, science at the elementary school level receives little attention and in many

schools is largely ignored. A major contributing factor for this neglect is teachers' lack of confidence in their own understanding of basic scientific concepts. This results in either completely abandoning science in the elementary school or teaching it in a superficial manner with "cookbook" experiments and "a right answer" approach. Either situation leaves children unable (or unwilling) to advance their views of scientific concepts. Teachers with misconceptions about scientific ideas are not likely to be able to develop scientifically accurate conceptions in their students. Observations by the authors show that student teachers, in presenting lessons to elementary shool children, frequently tend to accept childrens' naive concepts as correct. For example:

A senior elementary education major, teaching a lesson to second graders, accepted the weight of an object as the only determining factor for the object to sink or float. This student teacher rejected any other factor proposed by children. Clearly, this student teacher, in spite of taking several science classes in high school and at the University of Wyoming, had a naive view of the concepts of buoyancy and density, concepts commonly taught in elementary science.

Methods of Inquiry

This investigation involved the following procedures:

1) An analysis of several widely used elementary science programs determined the most frequently taught scientific concepts. Concepts representative of biological, physical, and earth sciences were selected as foci for investigation.
2) Twenty-nine (29) U.W. freshman elementary education majors and forty-three (43) U.W. senior elementary education majors were used as comparison groups.

3) Science content instrument designed by Christman (1970) was administered to the participants.

4) Attitudes toward science instrument designed by Cummings (1969) was administered to the participants.

5) Confidence toward teaching science designed by Alan J. McCormack (1969) was administered to the participants.

6) Statistical comparisons of levels of scientific understanding of attitudes of the freshmen and senior groups were completed. Several correlations, including science courses completed x level of understanding of scientific concepts, science courses completed x attitudes, and level of understanding x attitudes were determined.

Research Analysis Methods

The following null hypotheses were tested:

1) There is no relationship between the number of science courses taken by elementary education majors and their level of understanding of science concepts.

2) There is no relationship between the kind of science courses taken by elementary education majors and their level of understanding of science concepts.

3) There is no difference in the scientific conceptions of senior elementary education majors and freshmen majoring in elementary education.

4) There is no difference in the attitude of seniors in elementary education and the freshmen in elementary education toward science and the teaching of science.

5) There is no correlation between the level of understanding of science concepts of prospective elementary teachers and their attitude toward science.

6) There is no correlation between the level of understanding of science concepts of prospective teachers and their confidence in teaching of science to elementary school children.

7) There is no difference in the scientific conceptions of female elementary education majors and males majoring in elementary education.

8) There is no difference in the attitudes of females in elementary education and the males in elementary education toward science.

9) There is no difference in the confidence of females majoring in elementary education and males in elementary education in teaching science to elementary school children.

Pearson product-moment correlation was used to test hypotheses 1, 2, 5, 6, and 7. To test hypotheses 3, 4, 8, and 9 t-tests were employed.

Results

The results of this study will be outlined below as related to the major objectives for the research.

Objective #1 - To determine the level of understanding of selected science concepts of elementary and senior U.W. elementary education students.

A fifty-item multiple choice concept attainment assessment instrument was identified. The instrument was developed by H. G. Christman at Pennsylvania State University. This validated, highly reliable instrument incorporates a cross-section of science concepts that are ordinarily included in elementary science programs. Data collected from administration of this instrument would suggest:

1) Science concept understanding of both freshmen and senior students is at an undesirable, seriously low level. (Mean score for freshmen was 49.1%; while mean scores for seniors were 52.8%).

2) Students (both freshmen and seniors) are generally weak across all areas

of science (biology, physics, chemistry, earth science, and geology). They demonstrate no particular strength in any of the sciences, even though most opt to take biological courses rather than physical science courses.

3) There is no significant difference between the level of scientific understanding of freshmen compared to seniors. (See Table 2).

Objective #2 - To identify relationships between the type and number of science courses taken by elementary education majors and their level of understanding of science concepts.

Extensive demographic data was collected for all subjects and studies were completed of the number of different high school and university courses that were completed. These data suggest:

1. There is no overall relationship (there was a slightly negative correlation) between the total number of college level science courses completed and performance on the science concept attainment instrument.
2. There was no significant correlation between the number of hours completed in any specific science subject and performance on the science concept attainment instrument.

Objective #3 - to determine any differences in attitudes toward science of freshmen compared to seniors.

"An Instrument to Measure Attitudes Toward Science and the Scientist," developed by J. R. Cummings at Ohio State University was adopted for this study and administered to all subjects. Data collected suggest:

1. Freshmen are significantly lower (α = .02 level) in their attitudes toward science and scientists compared to seniors. (See Table 2).
2. A trend was noted in slightly more favorable attitudes by class from

freshmen through graduate level students.

3. In comparing students age-classes rather than academic classes it was noted that older students had more favorable attitudes toward science and scientists than younger students. More specifically, younger students were:

   a) less enthusiastic about science (in general)

   b) less attracted to participating in science activities

   c) less intrigued by scientific problems

   d) less likely to enjoy scientific investigations

   e) less favorable toward spending tax money for scientific research

Objective #4 - To identify any correlations among the number and types of science courses completed and attitudes toward science and teaching science.

The Cummings instrument was used to gather data related to this objective. The data suggest:

1. There is no general relationship between the number of hours of college/university science courses completed and attitudes toward science and science teaching. Students were just as likely to be more negative as they were to be more positive with increasing numbers of science courses completed.

2. There were some significant specific attitudinal factors uncovered relating to specific types of science courses completed. Negative attitudinal relationships were:

   a) The more biology and/or chemistry completed, the more likely students were to rate science as difficult to understand

   b) The more biology completed the more likely students were to say "science is boring."

   Positive attitudinal relationships were found as follows:

a) The more biology taken, the more students were attracted to scientific activities.

b) The more biology taken, the higher the importance rating given to science.

c) The more natural science (NASCI) courses taken, the more students were attracted to science activities.

d) The more natural science (NASCI) courses taken, the more students enjoyed science investigations.

e) The more physical geography courses taken, the more students were attracted to science activities.

f) The more physical geography courses taken, the more students found science classes interesting.

g) The more physical geography courses taken, the more students enjoyed doing science activities.

Objective #5 - To determine any correlation between the number and type of science courses taken by prospective elementary teachers and their confidence in their own abilities to teach science to elementary children.

Measures of 20 variables related to confidence in teaching science were taken by the SCICON Inventory, developed by Alan J. McCormack at the University of Northern Colorado. The following relationships were found:

1) There was negative correlation between performance by students on the concept attainment test and their self-ratings of confidence to teach science. (See Table 3).

2) There was no general relationship between total number of science courses taken and confidence to teach science.

3) There was a significant positive relationship between the number of natural science (NASCI) courses taken and general confidence in

teaching science.

4) There was a significant positive relationship between completion of a physical geography course and general confidence in teaching science.

5) There were no significant positive relationships between number of courses taken in biology, chemistry, physics, earth science, and astronomy and general confidence in teaching science.

In addition, relationships were found between certain science courses and specific variables of confidence in teaching science as follows:

1) Students having completed one or more courses in physical geography were significantly positive on 17 variables of confidence in teaching science.

2) Students having completed one or more courses in natural sciences (NASCI) were significantly positive on 10 variables of confidence in teaching science.

Objective # 6 - If there is a difference between male and female students in understanding of science concepts, attitudes toward science, and confidence in teaching science.

1) Male students had a significantly higher score on the content attainment then did the female students. (See Table 4).

2) There was no significant difference between the attitudes of males and females toward science. (See Table 4).

3) The male students felt more confident in teaching science than did the female students. (See Table 4).

Objective # 7 - If there is a correlation between scores on the content attainment test and attitude toward science.

Both freshmen and seniors showed a large negative correlation between the score on the content attainment and attitudes toward science. (See Table 3).

Objective # 8 - If there is a correlation between scores on the content attainment test and confidence in teaching science.

Both freshmen and seniors showed a negative correlation between the score on the content attainment and confidence in teaching science to elementary school children. (See Table 3).

Discussion

The results of this study appear to substantiate the following interpretations:

1) U.W. elementary education students are being inadequately prepared to teach science in terms of attainment of a reasonable level of understanding of scientific concepts currently included in elementary school science curricula. Since no significant differences can be found between understanding of science concepts in comparing freshmen to seniors, it would seem reasonable to have concerned faculty consider various ways for improvement of the science backgrounds of these students.
2) It appears that simply having these students take greater doses of traditional college science courses does not favorably impact understanding of science concepts, attitudes toward science, or confidence in personal ability to teach science.
3) Freshmen appear to have a significantly serious negative attitudinal complex regarding science and science teaching. It might be very useful to give special attention to this group of students in terms of experimenting with ways to improve attitudes.
4) Though there is a discernible trend in the direction of positive attitudes toward science by students as they mature from freshman to senior level, this trend is completely unrelated to the number of standard general education science courses completed. Whether this trend is attributable

to maturity or to some other factor is not clear.

5) Two particular types of courses - physical geography and natural sciences (NASCI) - appear to be significantly potent in producing both more favorable attitudes and greater confidence in prospective elementary teachers. Comparisons of instructional style, typical learning activities, objectives, course materials, and means of evaluation of these courses as compared to "standard" general education or lower division science courses would be useful.

If positive attitudes toward science and confidence in ability to teach science are desirable objectives for a program for preparation of elementary teachers, then it would seem propitious to identify and implement more generally those factors that seem to result in achievement of these objectives. If current lower division science courses are not achieving student attainment of science concepts, or positive attitudes about science, or confidence in the ability to teach science, then we have a very serious problem.

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APPENDICES

Tables 1 - 5

TABLE 1

SCIENCE HOURS TAKEN IN COLLEGE

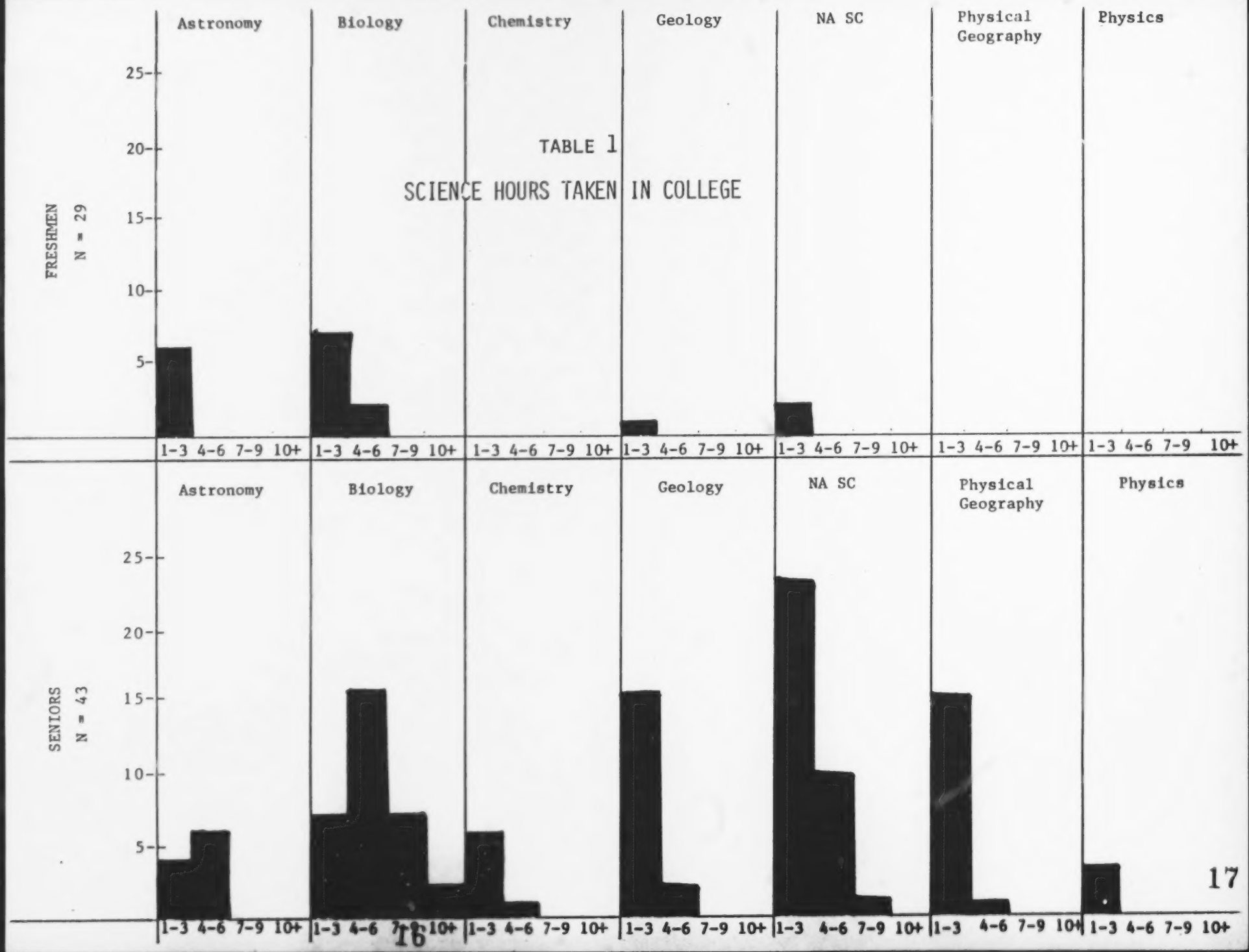

TABLE 2

FRESHMEN vs SENIORS

	FRESHMEN (N=29)	SENIORS (N=43)
CONTENT MEAN	49.1%	52.8%
ATTITUDES* TOWARD SCIENCE	2.8	2.5
CONFIDENCE* IN TEACHING SCIENCE	2.8	2.3

* $\alpha = .02$

TABLE 3

CORRELATION COMPARISONS

	Freshmen (N=29)	Seniors (N=43)
r Content/Attitude	-.356	-.421
r Content/Confidence in Teaching	-.207	-.053

TABLE 4

MALES vs FEMALES

	MALES (N=26)	FEMALES (N=70)
CONTENT* MEAN	57.6	51.2
ATTITUDE/ SCIENCE	2.57	2.69
CONFIDENCE* IN TEACHING	2.39	2.71

*α - .02 LEVEL

TABLE 5

EFFECTS OF VARIOUS TYPES OF SCIENCE COURSES

- THE MORE HOURS TAKEN IN SOME TRADITIONAL CONTENT AREAS (E.G., BIOLOGY) THE MORE NEGATIVE THE ATTITUDES TOWARD SCIENCE.

- THE MORE HOURS TAKEN IN SOME TRADITIONAL CONTENT AREAS (E.G., BIOLOGY) THE LESS CONFIDENCE IN TEACHING SCIENCE TO ELEMENTARY SCHOOL CHILDREN.

- THE MORE HOURS TAKEN IN COURSES DESIGNED SPECIFICALLY FOR TEACHERS (E.G., NA SC AND PHYSICAL GEOGRAPHY) THE MORE POSITIVE ATTITUDES TOWARD SCIENCE.

- THE MORE HOURS TAKEN IN COURSES DESIGNED SPECIFICALLY FOR TEACHERS (E.G., NA SC AND PHYSICAL GEOGRAPHY) THE MORE CONFIDENCE IN TEACHING SCIENCE TO ELEMENTARY SCHOOL CHILDREN.